

Inclusive Charm Production in Two Photon Collisions at LEP with the L3 Detector

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Louisiana State University

18 - 21 April 1998

1998 Joint APS/AAPT Meeting

Columbus, Ohio

 **Two Photon Introduction**

 **Motivation**

 **Analysis**

 **Results (Preliminary)**

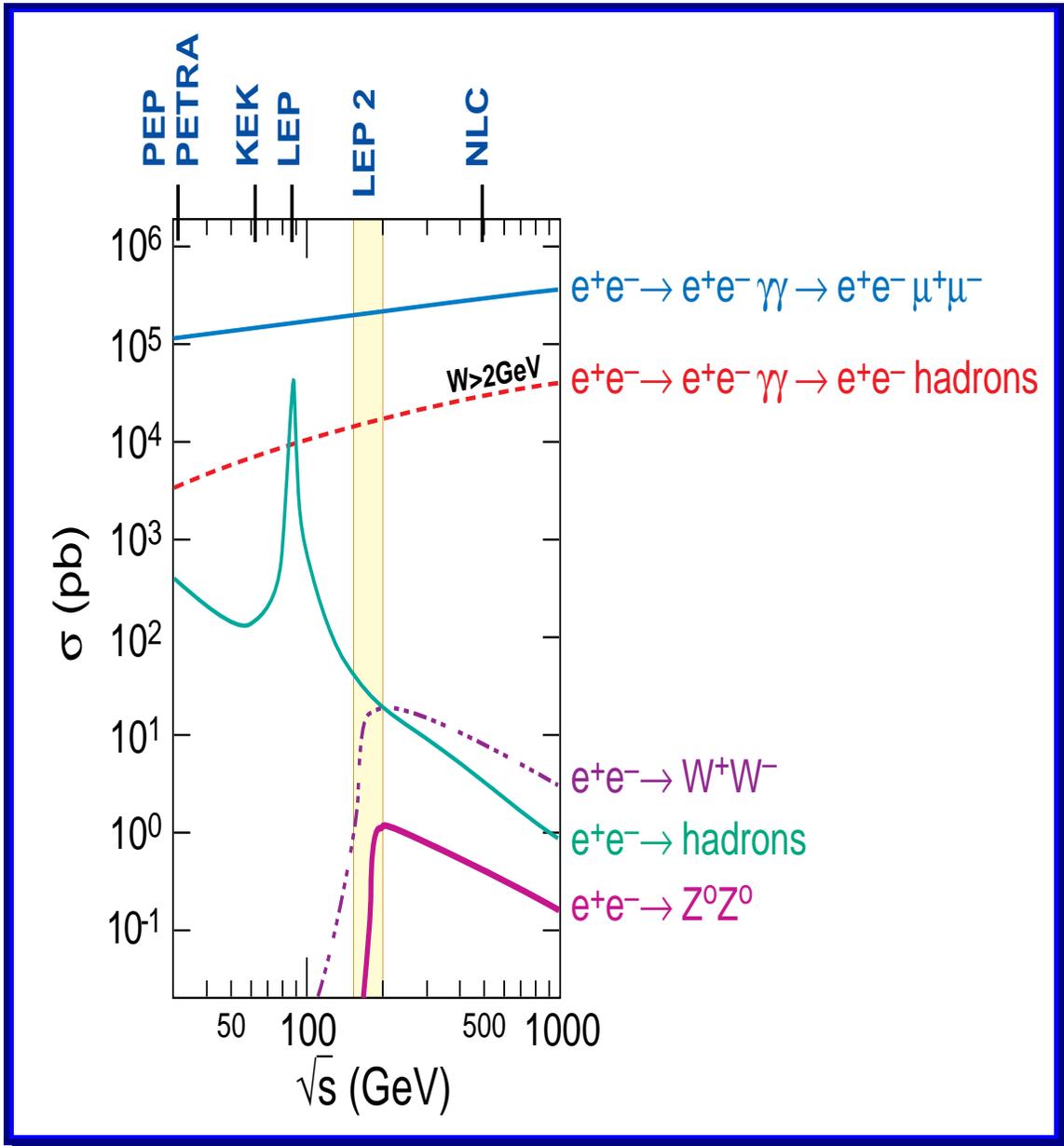
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Two Photons



- Main contribution to hadron production at LEP



- Background to other processes.

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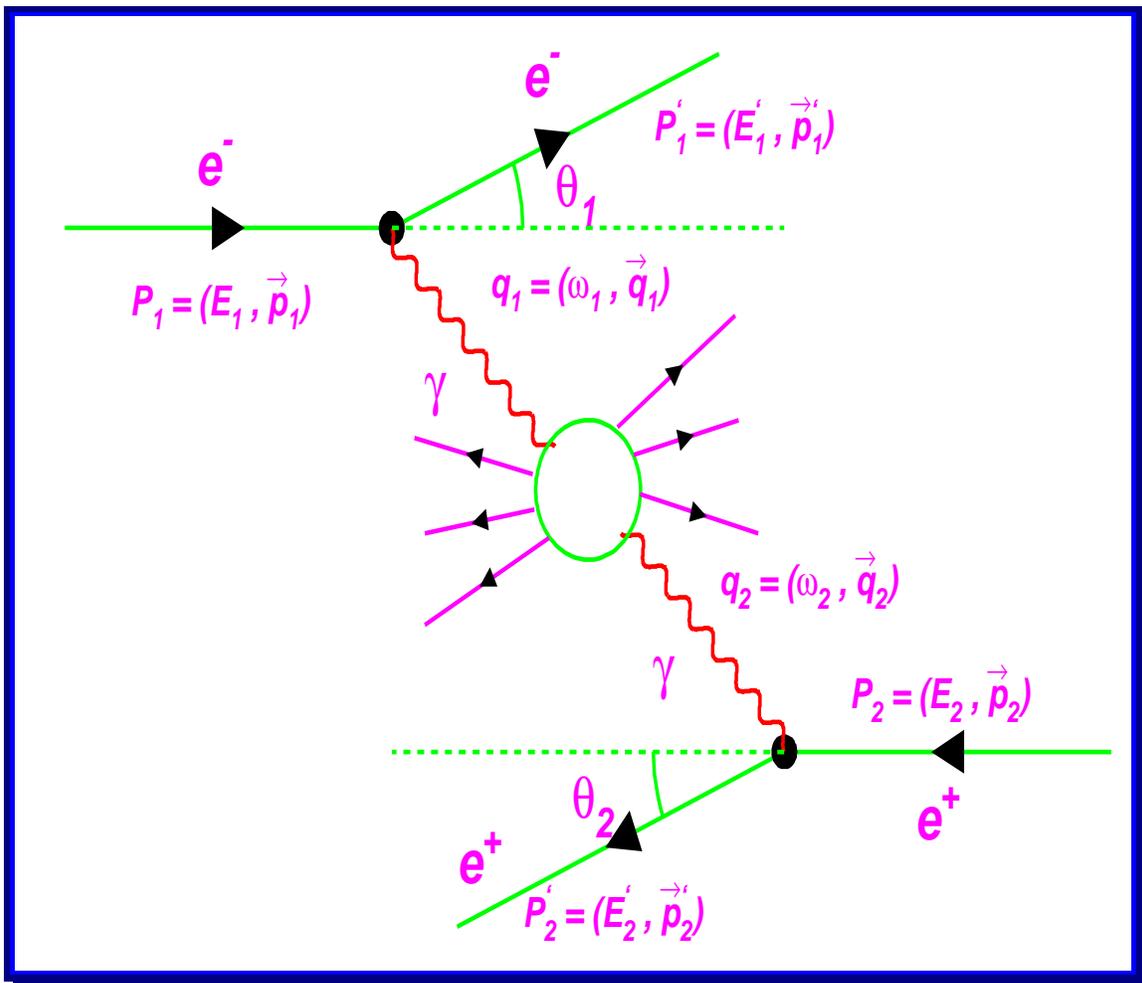
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Two Photons



- $Q_i^2 = -q_i^2 = 2E_i E_i' (1 - \cos\theta_i)$
- $W_{\gamma\gamma}^2 = (\sum_h E_h)^2 - (\sum_h \vec{p})^2$

☐ Photon Photon Scattering

- ▣ **Untagged Events** ($Q_i^2 \approx 0$)
- ▣ **Exclusive/Inclusive Hadronic States**

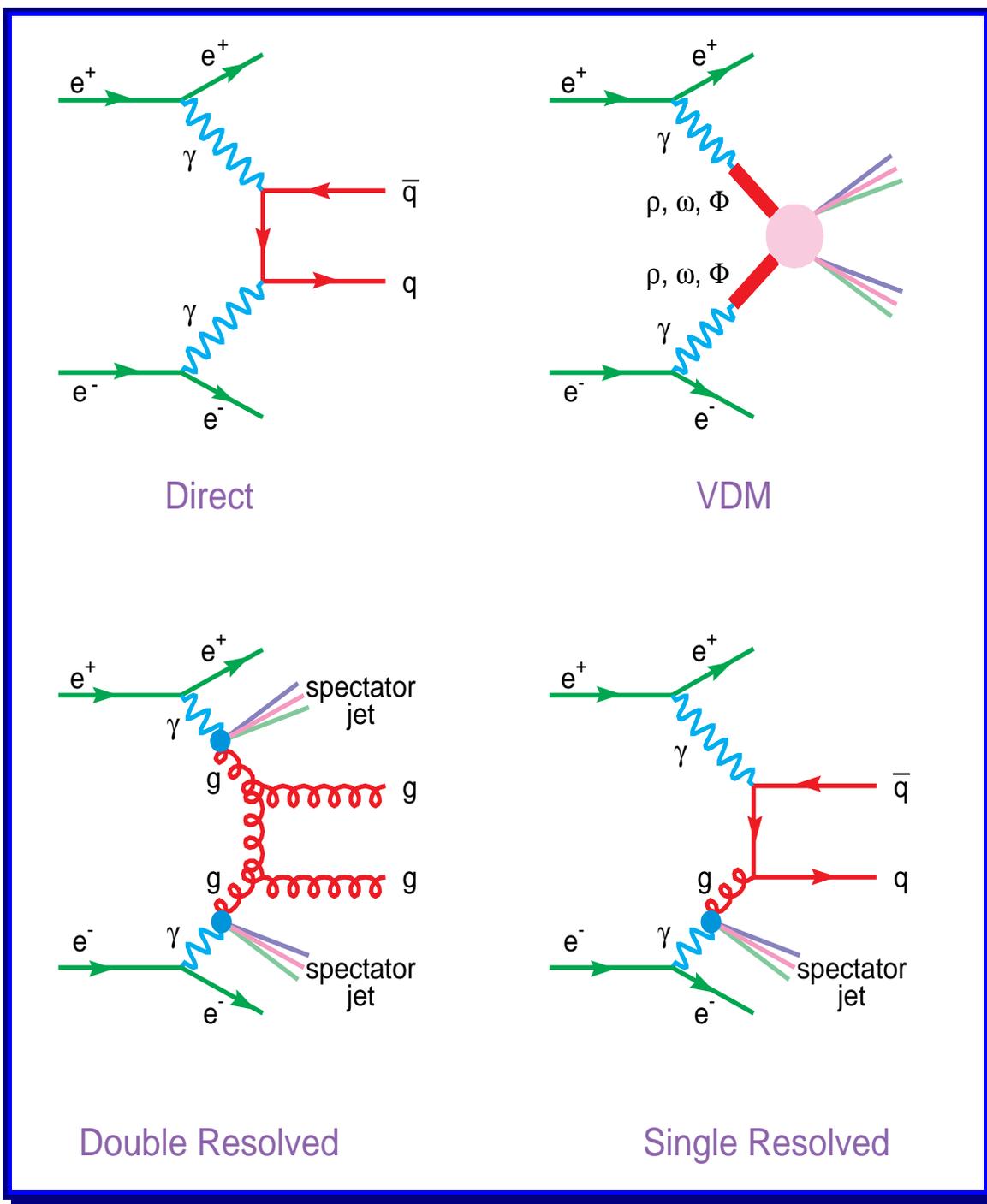
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Inclusive Hadronic Production



VDM Diagram is dominant at low Q^2

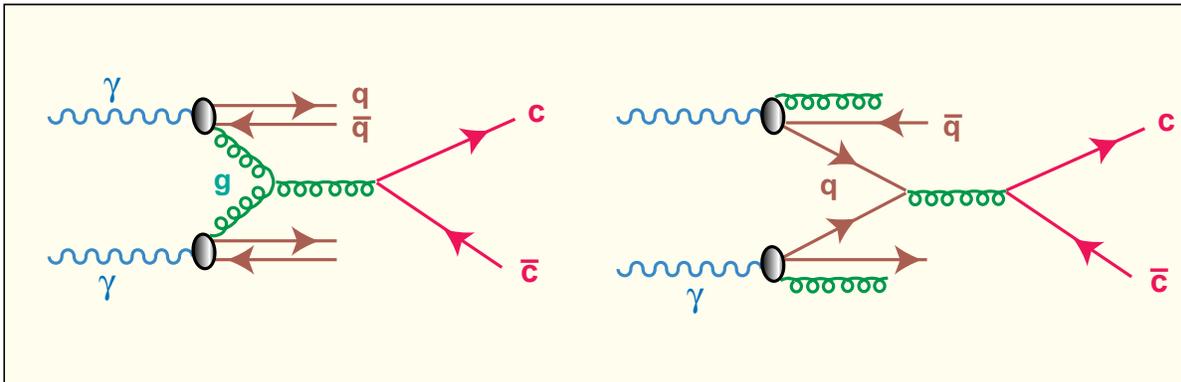
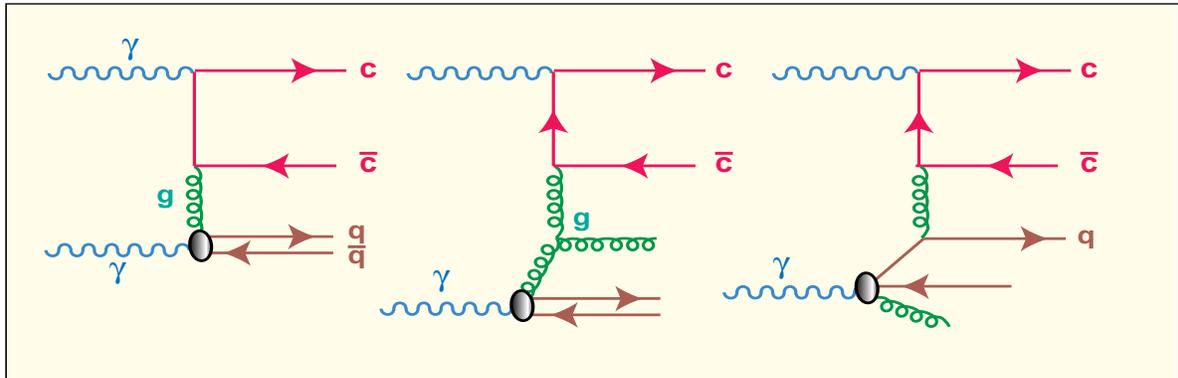
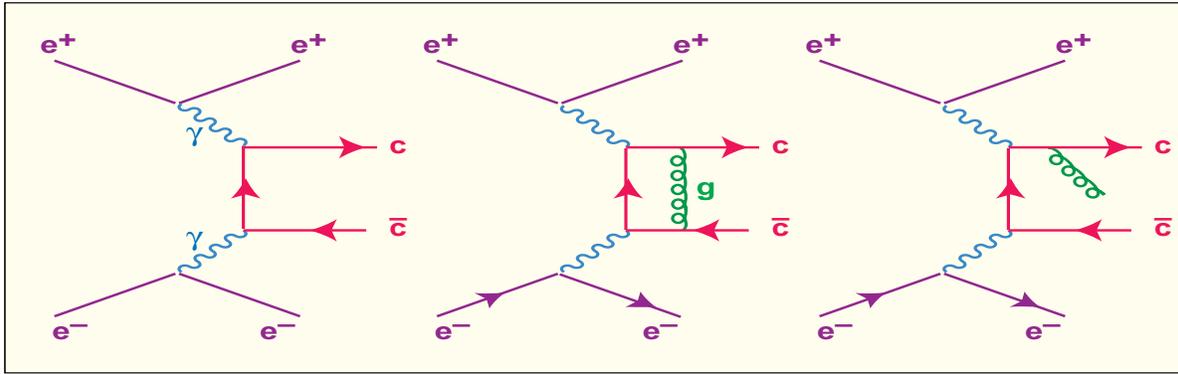
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Charm Production



- Direct : Born term + virtual and real QCD corrections
- Single resolved : $\gamma g \rightarrow c\bar{c}$
measurement of the gluon content in photon
- Double resolved (negligible at LEP energies)

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Motivation

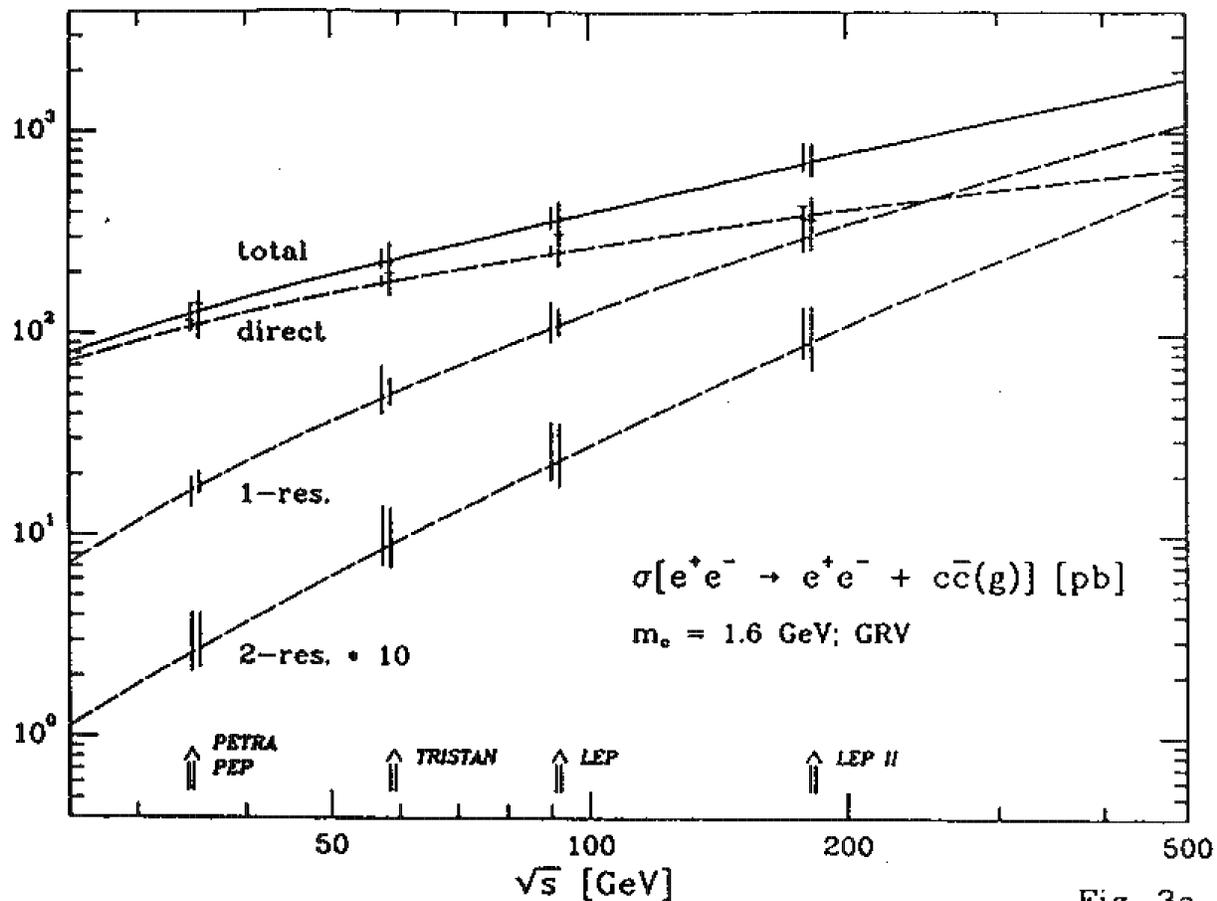


Fig. 3a

➡ Ref: M.Drees, M.Kramer, J.Zunft and P.M. Zerwas
 Physics Letters B 306 (1993) 371

- Test of QCD
- Gluon content of Photon (resolved...)
- Constrain Mass of Charm Quark
- First LEP2 measurement

$$\int \mathcal{L} dt = 165 \text{ pb}^{-1} \text{ at } \sqrt{s} = 91 - 183 \text{ GeV}$$

Hadron Selection

- $N_{tracks} \geq 5$
- $E_{Lumi}/E_{beam} < 0.4$
- $E_{vis}/\sqrt{s} < 0.38$
- $W_{vis} > 3 \text{ GeV}$

\sqrt{s} (GeV)	L (pb^{-1})	Events	background %
183	52	116760	0.2
161-172	21	44450	0.2
130-140	12	18180	0.2
91	80	93020	2.4

MC: PYTHIA vers. 5.722

$L_{\gamma\gamma}$ EPA ($Q^2 < 1 \text{ GeV}$)

Background Sources

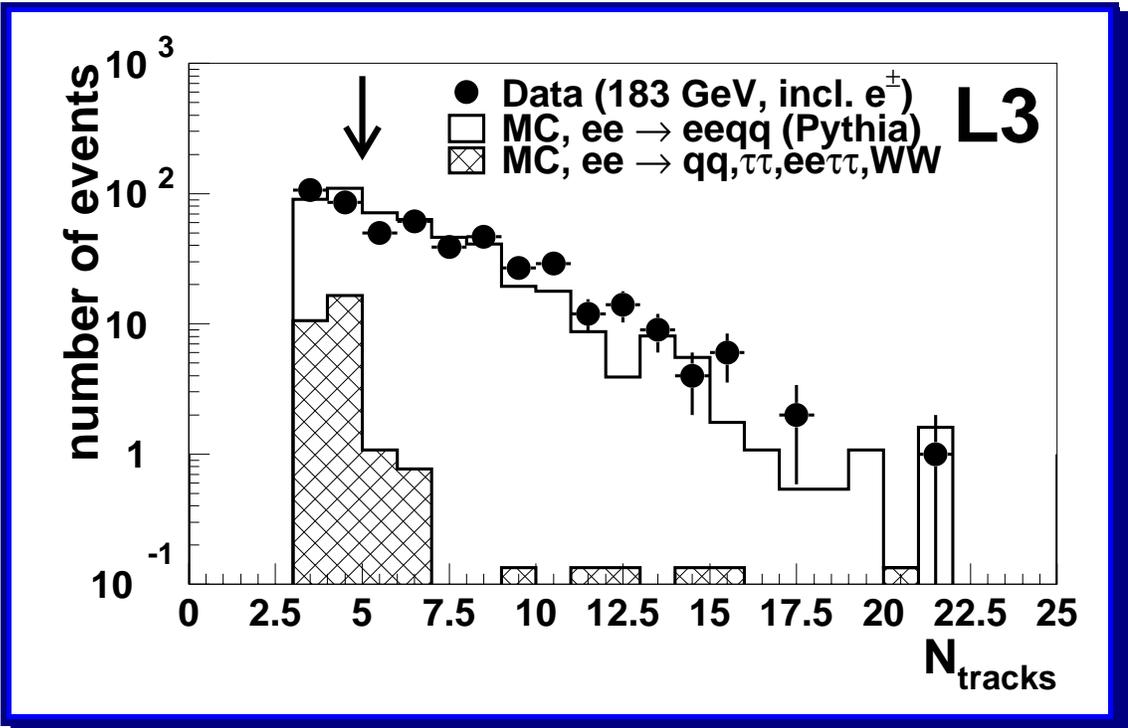
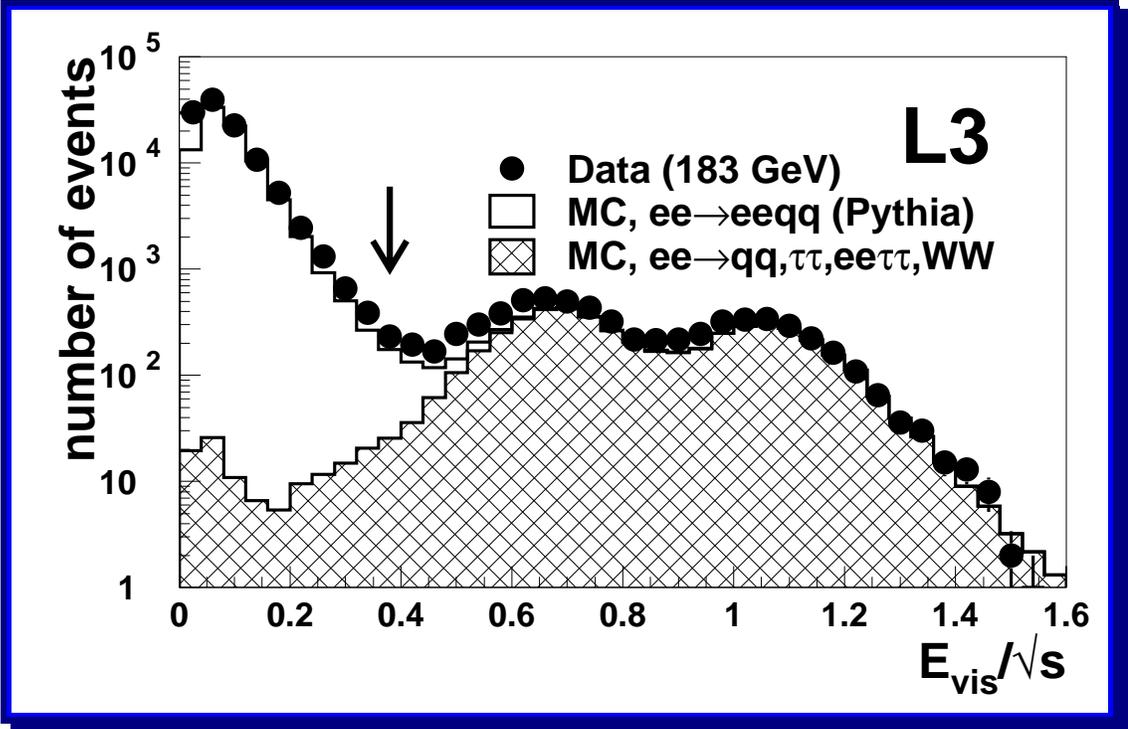
$e^+e^- \rightarrow q\bar{q}$ (PYTHIA)

$e^+e^- \rightarrow \tau^+\tau^-$ (KORALZ)

$e^+e^- \rightarrow W^+W^-$ (KORALW)

$e^+e^- \rightarrow e^+e^-\tau^+\tau^-$ (DIAG36)

Analysis



Lepton Selection

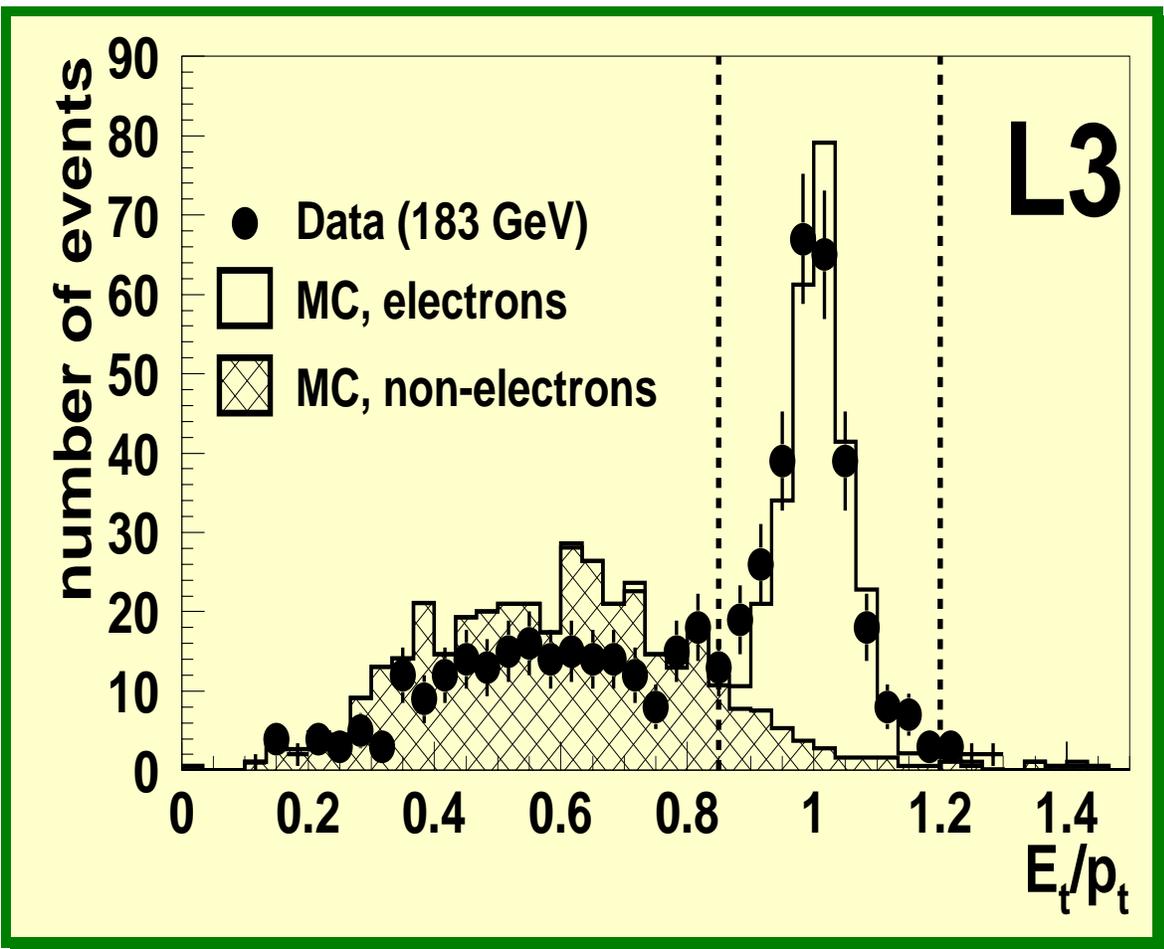
$c \rightarrow \text{lepton}(s)$

μ^\pm Selection

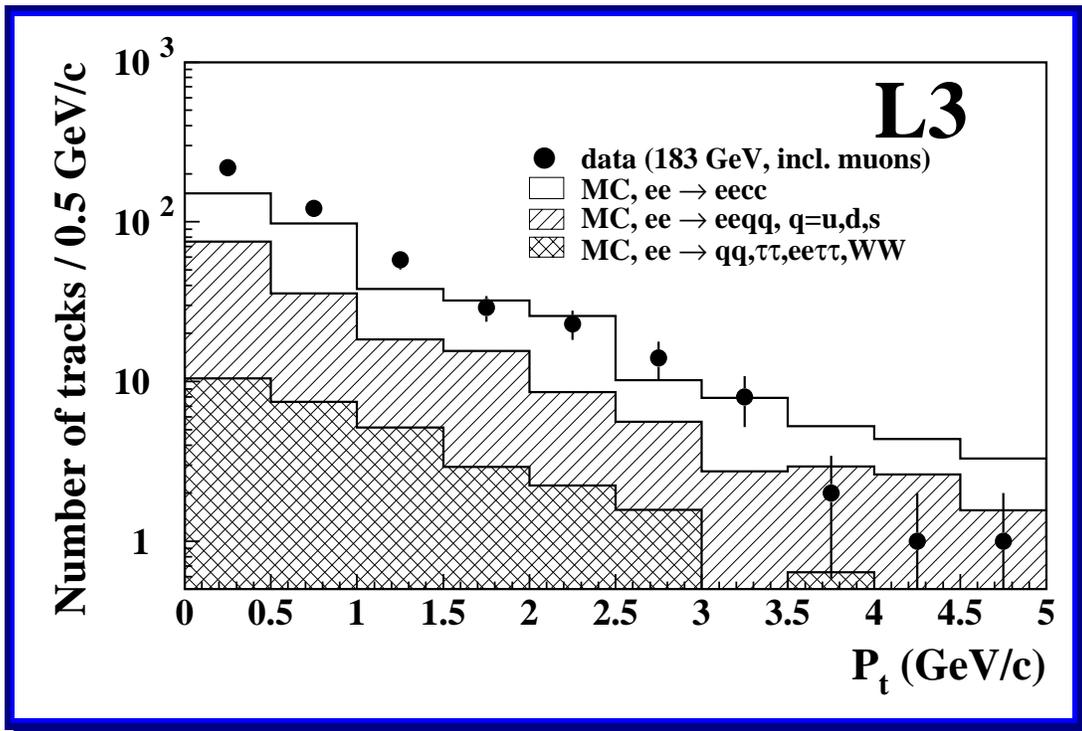
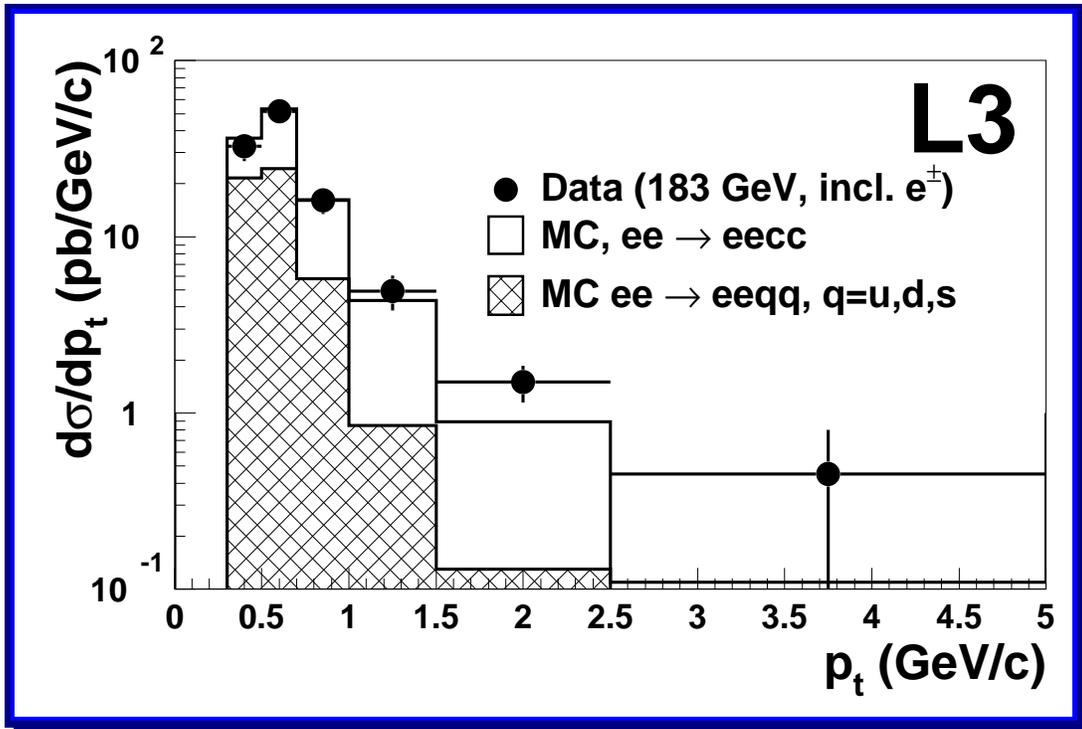
$|\cos \theta| < 0.90$
 $P_\mu > 2 \text{ GeV}/c$
 $P_\mu < 0.2E_{\text{beam}}$

e^\pm Selection

$|\cos \theta| < 0.72$
 $E_e > 0.5 \text{ GeV}$
 $\Delta\phi < 20 \text{ mrad}$
 $0.85 < dE/dx < 1.15$
 $0.85 < E_T/p_T < 1.2$



Analysis



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Preliminary Results

\sqrt{s} GeV	183	161-172	130-140	91
$\int \mathcal{L} dt pb^{-1}$	52.22	21.15	12.05	79.74
ϵ_{trig} (%)	78.6 ± 1.1	82.6 ± 1.8	83.0 ± 2.4	87.2 ± 1.0

Electrons

N_{obs}	301	118	55	210
N_{exp}	294	117	46	144
N_{bkg}	127	54	22	98
Π_{elec} (%)	86.4 ± 1.5	80.1 ± 1.8	86.1 ± 1.5	86.1 ± 3.3
ϵ_{elec} (%)	23.4 ± 1.0	22.2 ± 1.0	18.7 ± 2.1	11.9 ± 1.2
Π_{charm} (%)	58.5 ± 2.1	54.8 ± 2.3	59.5 ± 5.5	55.6 ± 4.8
ϵ_{charm} (%)	0.56 ± 0.03	0.54 ± 0.03	0.49 ± 0.07	0.28 ± 0.04

Muons

N_{obs}	52	17	-	62
N_{exp}	42	16	-	48
N_{bkg}	18	8	-	26
Π_{μ} (%)	100.0	100.0	-	100.0
ϵ_{μ} (%)	33.4 ± 1.5	33.4 ± 1.5	-	33.4 ± 1.5
Π_{charm} (%)	59.7 ± 6.0	56.8 ± 5.8	-	66.7 ± 9.6
ϵ_{charm} (%)	0.07 ± 0.01	0.07 ± 0.01	-	0.07 ± 0.02

Cross section of Charm Production in $\gamma\gamma$ Collisions

$$\sigma = \frac{N_{sel} \Pi_{charm}}{\mathcal{L} \epsilon_{charm}}$$

☐ $e^+e^- \rightarrow e^+e^-c\bar{c}$ (**Electron Tag**)

$$\sigma_{183 \text{ GeV}} = 755 \pm 75 \text{ (stat)} \pm 102 \text{ (syst)} \text{ [pb]}$$

$$\sigma_{161-172 \text{ GeV}} = 682 \pm 116 \text{ (stat)} \pm 114 \text{ (syst)} \text{ [pb]}$$

$$\sigma_{130-140 \text{ GeV}} = 672 \pm 153 \text{ (stat)} \pm 191 \text{ (syst)} \text{ [pb]}$$

$$\sigma_{91 \text{ GeV}} = 589 \pm 76 \text{ (stat)} \pm 134 \text{ (syst)} \text{ [pb]}$$

☐ $e^+e^- \rightarrow e^+e^-c\bar{c}$ (**Muon Tag**)

$$\sigma_{183 \text{ GeV}} = 936 \pm 228 \text{ (stat)} \pm 178 \text{ (syst)} \text{ [pb]}$$

$$\sigma_{161-172 \text{ GeV}} = 711 \pm 330 \text{ (stat)} \pm 134 \text{ (syst)} \text{ [pb]}$$

$$\sigma_{91 \text{ GeV}} = 558 \pm 139 \text{ (stat)} \pm 166 \text{ (syst)} \text{ [pb]}$$

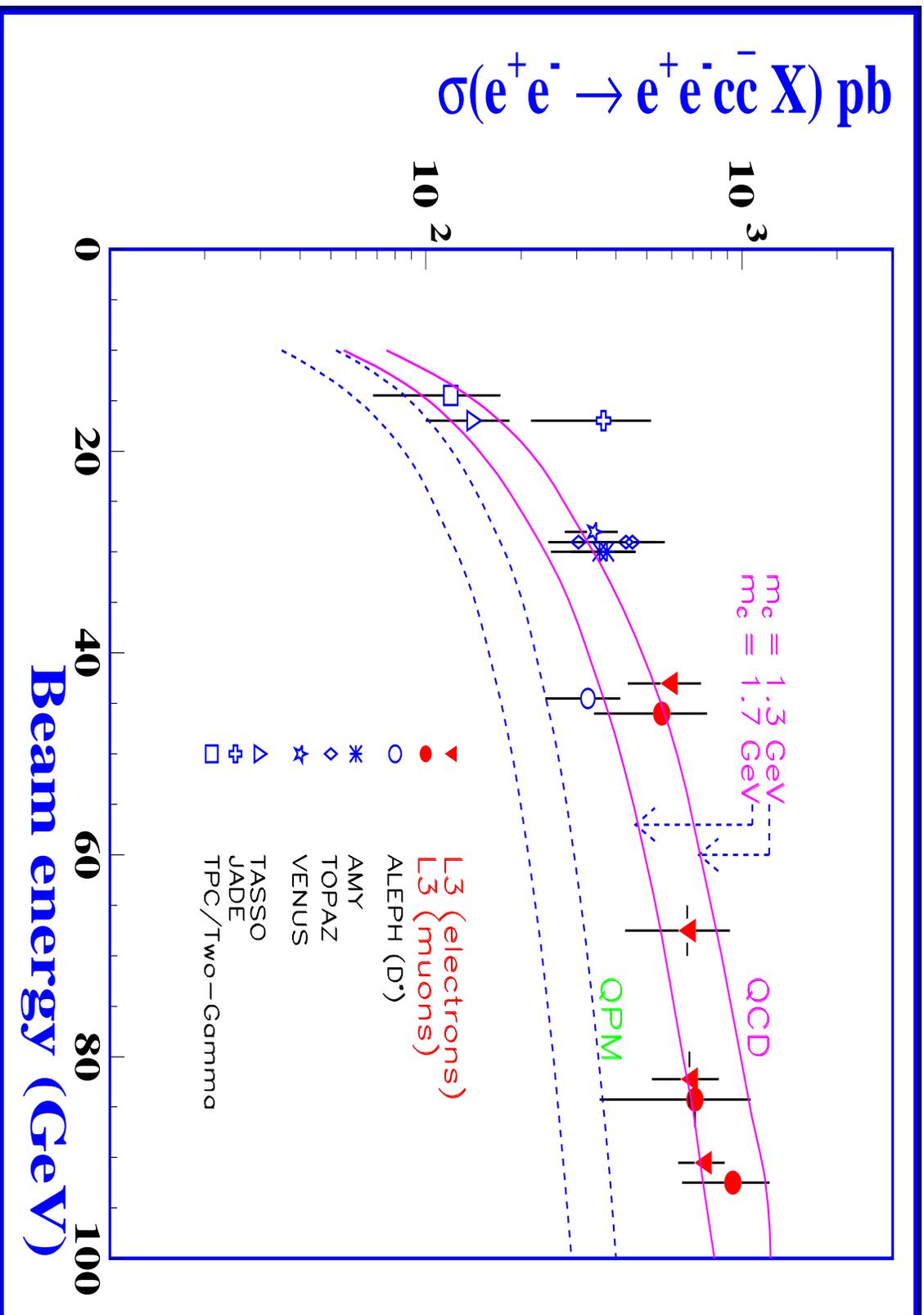
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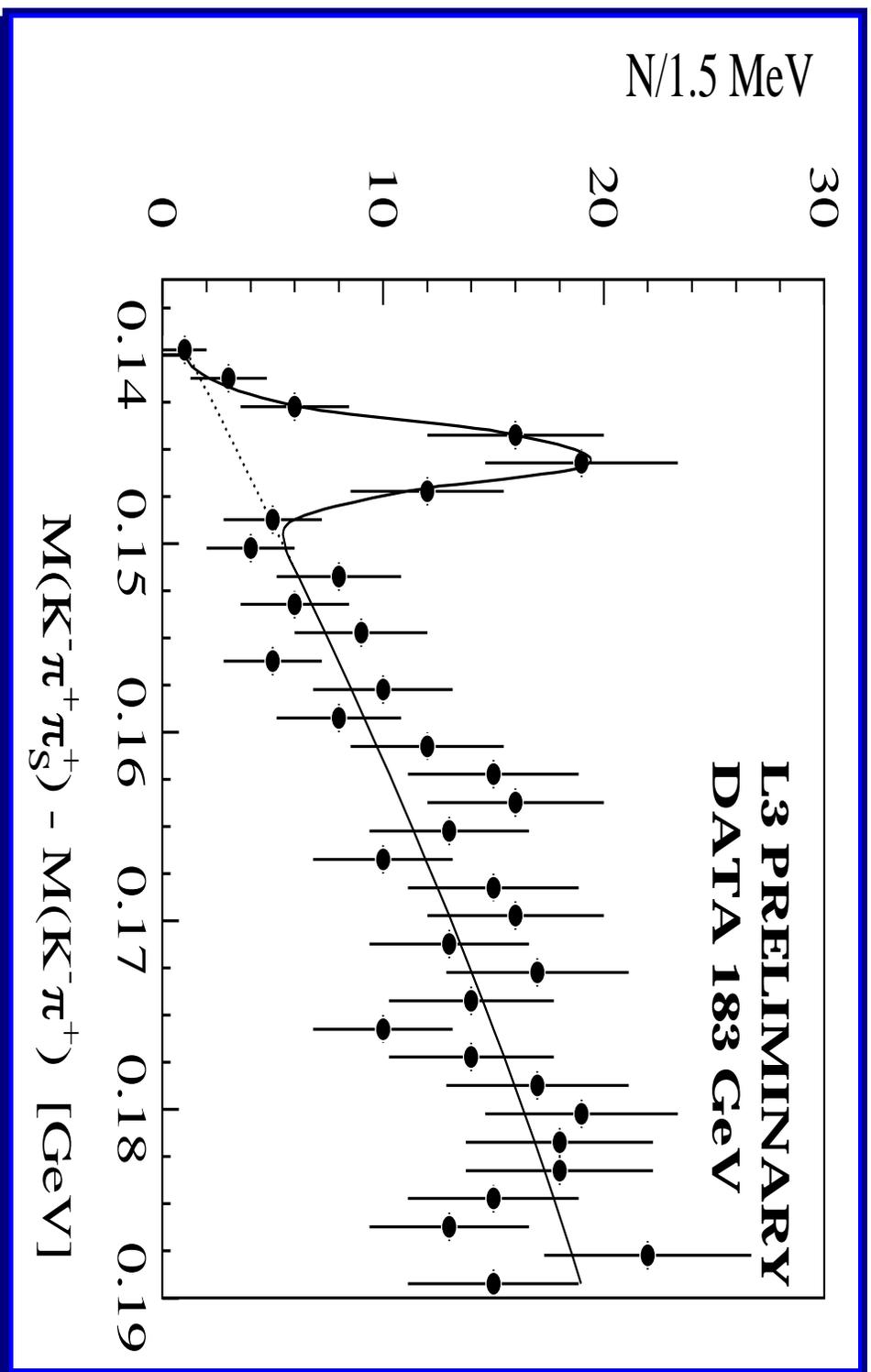
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Preliminary Results



Analysis

$$D^{*\pm} \rightarrow D^0 \pi_s^\pm \rightarrow K^\mp \pi^\pm \pi_s^\pm$$



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Conclusion

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- ❑ Cross Sections of inclusive charm production in $\gamma\gamma$ collisions have been measured with L3 detector at LEP1, LEP1.5 and LEP2 energies using **lepton tag**.
- ❑ Results are **in agreement** with QCD predictions.
- ❑ Additional Charm Tag analyses are in progress.
- ❑ Results are **Preliminary**.